PATENT SPECIFICATION

725,503

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COMPLETE SPECIFICATION

Ceramic Protective Layer for Metallic Gas Turbine Elements containing Chromium

We, AKTIENGESELLSCHAFT BROWN, BOVERI & CIE, of Baden, Switzerland, a Swiss Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In connection with metallic constructional elements of heat engines subjected to high thermal stresses, for example exhaust gas pipes of aircraft engines or blades of gas turbines, it is known to cover these elements with a thin ceramic layer as heat insulation for the parts to be protected or as a protection against corrosion and mechanical erosion caused by the hot gases.

It has now been found that when building oil-fired gas turbines, those parts which are subjected to high thermal stresses have to be very carefully protected against attack by liquid oil fuel slags which contain injurious components such as vanadium compounds which prevent the formation of protective layers of scale on the steel used for the constructional elements, or destroy existing scale layers, so that progressive scaling for instance of the combustion chamber walls or gas turbine blades becomes facilitated.

It is known that magnesium oxide is not or only very slightly attacked by such slags. Pure chrome metal is also highly resistant to such attacks. If such materials are to be used when applying an effective ceramic layer to constructional elements consisting of heat resistant chrome-steel, the layer must adhere firmly to the surfaces which are to be treated. It must also combine well with magnesium oxide. Furthermore it should be possible to apply the protective material in layers with a total thickness of more than 1 mm. Finally a covering layer of chrome-metal may also be required which must be capable of combining with the other components of the ceramic protective layer. The whole protective layer must have a good heat conductivity and be unaffected by temperature variations. Exhaustive tests have shown that a protective layer which is effective against attacks by fuel slags containing vanadium can be produced on a foundation of chrome-steel, if together with the aforenamed materials an enamel is used containing chromium oxide and having good adhesive properties. The expansion of the enamel due to heat should be somewhat less than that of the steel.

The invention consists in a ceramic protective multi-layer on metallic gas turbine constructional elements containing chromium so as to protect them against attacks by fuel slags containing vanadium, characterised by a layer of an enamel containing chromium oxide which is fired on to the element which is to be protected and further layers of chromium oxide enamel each of which has an increasing amount of magnesium oxide mixed with it and is successively fired on to the previous layer.

The invention also consists in ceramic protective multi-layers in accordance with Claims 2 and 3 below.

The accompanying drawings illustrate two forms of protective layers according to the invention, the protective layer shown in Figure 1 being made up only of ceramic materials, whilst the protective layer according to Figure 2 has in addition a cover layer of pure chrome-metal.

The protective layer shown in Figure 1 is constructed for instance as follows:—First of all a layer 2 of pure enamel containing chromium oxide is applied to a chrome-steel foundation 1, the chromium content of the latter being about 21% and the heat expansion coefficient of layer 2 being somewhat smaller than that of the steel. The enamel can for instance have the following composition by weight: 24% borax, 28% felspar, 23% quartz, 5% fluor-spar, 15% cryolite, 5% soda. Four parts by weight of chromium oxide in powder form are added to 100 parts of this mixture. The whole mass is mixed, melted, and again pulverised after it has solidified. This layer is then applied to the foundation layer and fired at 850 to 900° C. for several minutes. After cooling, a further layer 3 of the same enamel mixed with about 10 to 20% magnesium oxide powder is sprayed or painted on to layer 2 and fired like the latter. Further layers 4 and 5 contain about 25 to 35% and about 40 to 60% magnesium oxide respectively in addition to

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pure enamel. The layers with a high percentage of magnesium oxide provide a very good protection for the constructional elements against attacks by liquid slags containing vanadium, whilst the layers with less magnesium oxide have a very good adhesive property. The whole structure is so firm and adheres to the metal so well that when sudden changes in temperature occur the ceramic layer does not scale off.

As shown in Figure 2, the ceramic protective layer is provided with a cover layer 6 of pure chromium. The foundation 1 again has an adhesive layer 2 of pure enamel containing chromium oxide applied to it, successive layers 3 containing up to 60% magnesium oxide being applied to layer 2. The chromium for the cover layer 6 is applied in the form of powder to the last layer whilst the latter is still at light-red heat, so that it binds with the components of the ceramic layer. The metallic powder also sinks into the soft ceramic layer so that it is very closely united with the latter.

Protective layers with a metallic cover layer can be provided to great advantage on gas turbine blades. The cover layer can be strengthened and covered by chromium plating. Such a metallic covering of pure chromium which totally encloses the ceramic protective layer can also be given a smooth polish, whereby sharp edges of the blades are maintained. As a result of the ceramic layer, which acts mainly as an adhesive layer, a temperature gradient occurs when heat energy is supplied, so that the temperature of a blade provided with a protectiv layer is somewhat lower than that of a blade without protective layer for the same gas temperature.

By means of the described ceramic protective layers attacks on gas turbine elements by fuel oil slags containing vanadium are practically eliminated. The life of combustion chamber walls and other parts which may come into contact with the liquid slag is thus considerably lengthened.

What we claim is:—

1. Ceramic protective multi-layer on metallic gas turbine constructional elements containing chromium so as to protect them against attacks by fuel slags containing vanadium, characterised by a layer of an enamel containing chromium oxide which is fired on to the element which is to be protected and further layers of chromium oxide enamel each of which has an increasing amount of magnesium oxide mixed with it and is successively fired on to the previous layer.

2. Ceramic protective multi-layer as in Claim 1, characterised by a final layer of pure chrome metal.

3. Ceramic protective multi-layer constructed substantially as described with reference to the accompanying diagrammatic drawings.

MARKS & CLERK

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725,503 COMPLETE SPECIFICATION
1 SHEET

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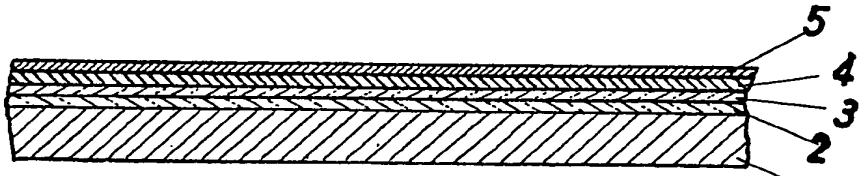

Fig.1

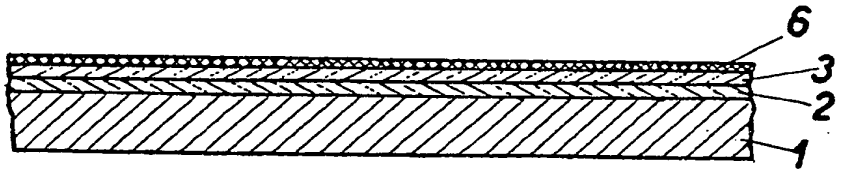

Fig.2